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Signature

March 6, 2004
Date of Signature

Re:	Application of:	Berman, Michael J.
	Serial No.:	09/553,140
	Filed:	April 20, 2000
	For:	Determination of Film Thickness During Chemical Mechanical Polishing
	Group Art Unit:	2623
	Examiner:	Vikkram Bali
	Our Docket No.:	99-230(1003-0547)

BRIEF ON APPEAL

Sir:

This is an appeal under 37 CFR § 1.191 to the Board of Patent Appeals and Interferences of the United States Patent and Trademark Office from the final rejection of claims 1-28 of the above-identified patent application. These claims were indicated as finally rejected in an Office Action dated October 6, 2003. Three copies of the brief are

filed herewith. Please charge **$330.00** to Deposit Account 12-2252 to cover the fee required under 37 CFR § 1.17(f). Also, please provide any extension of time which may be necessary and charge any fees which may be due to Deposit Account No. 13-0014, but not to include any payment of issue fees.

(1) REAL PARTY IN INTEREST

LSI Logic Corporation is the owner of this patent application, and therefore the real party in interest.

(2) RELATED APPEALS AND INTERFERENCES

There are no appeals or interferences related to this patent application.

(3) STATUS OF CLAIMS

Claims 1-28 are pending in the application.

Claims 1-28 stand rejected and form the subject matter of this appeal. Claims 1-28 are shown in the Appendix attached to this Appeal Brief.

(4) STATUS OF AMENDMENTS

Applicants filed a Response to Office Action dated July 21, 2003 ("Response") responsive to an Office Action dated April 21, 2003 which included amendments to the claims. A final Office Action dated October 6, 2003 ("Final Office Action") was designated by the Examiner to be responsive to the Response. Applicants have filed no amendments after the Final Office Action.

(5) SUMMARY OF THE INVENTION

Independent claim 1 is directed to a method of determining the layer thickness of a substrate during the polishing of the substrate. (Page 1, lines 6-8). The method includes acquiring an image using high speed imaging. A number of examples of high speed imaging are provided in the specification. By way of non-limiting example, the high speed image may be acquired by a high speed camera (page 10, lines 6-9), a short pulse of coherent light and a conventional camera (page 10, line 19 through page 11, line 11), or a broadband flash and a conventional camera (page 11, line 12 through page 12, line 6). The camera may be located within a polishing pad or just outside of the polishing pad. (See e.g. page 9, line 22 through page 10, line 2).

The high speed image is compared against a plurality of stored images. The stored images correspond to user identified areas of the substrate that have been imaged and stored. (Page 15, lines 4-10). If the high speed image matches any one of the previously stored images, the thickness of the layer is ascertained. (Page 13, lines 7-10). One method of determining the thickness of the layer, as claimed in claim 7, is to convert pixels of the image into layer thickness. By way of non-limiting example, this may be accomplished using measuring programs such as are commercially available from IPEC Precision. (Page 13, lines 5-7).

Claim 8 includes the limitation that the layer thickness determination is performed in situ. Fig. 1 provides one non-limiting example of an in situ method. A substrate (14) is held and rotated by a wafer carrier (12). The rotational speed of the wafer during the polishing process may reach linear speeds of a few hundred feet per minute. (Page 7,

lines 18-20). As the substrate is rotated, a polishing platen (20) and pad (22) are also rotated. During this polishing process, an image is captured by an in situ image acquisition unit (26).

Claim 9 is directed to an apparatus for determining the thickness of a substrate that includes a programmed processing unit (38), and an in situ high speed imager (26) as discussed above with respect to claim 8. (See e.g. Fig. 1).

Claim 15 is directed to a method for determining the thickness of a substrate using a high speed imager. Claim 15 also includes a limitation that the polishing is stopped when the layer thickness of an acquired image is a predetermined valued indicating end-point. One non-limiting example of this limitation is shown in Fig. 2. In accordance with the method depicted in Fig. 2, once a determined layer thickness is within a tolerance band for the end-point thickness, the polishing process is stopped. (Page 15, lines 1-3).

(6) ISSUES

Whether claims 1, 2, 8-9 and 12 are unpatentable under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,640,242 to O'Boyle et al. (hereinafter "O'Boyle").

Whether claims 3-7, 10-11 and 13-28 are unpatentable under 35 U.S.C. § 103(a) as being obvious over O'Boyle in view of U.S. Patent No. 6,361,646 to Bibby, Jr. et al. (hereinafter "Bibby").

(7) GROUPING OF CLAIMS

The claims do not all stand or fall together.

Claims 1-6 form a first separately patentable group which is argued independently of the other claims for purposes of this appeal.

Claim 7 forms a second separately patentable group which is argued independently of the other claims for purposes of this appeal.

Claims 8-14 form a third separately patentable group which is argued independently of the other claims for purposes of this appeal.

Claims 15- 20 and 23-28 form a fourth separately patentable group which is argued independently of the other claims for purposes of this appeal.

Claim 21 forms a fifth separately patentable group which is argued independently of the other claims for purposes of this appeal.

Claim 22 forms a sixth separately patentable group which is argued independently of the other claims for purposes of this appeal.

(8) ARGUMENT

First Claim Grouping: **Claims 1-6 are Not Unpatentable Over the Prior Art**

Discussion re: Patentability of Claim 1

1. Claim 1

Claim 1 stands rejected as allegedly being obvious in view of O'Boyle. Claim 1 includes the following limitations:

> A method of determining layer thickness of a particular area of a substrate during CMP of the substrate, the method comprising the steps of:
>
> acquiring an image of a particular area of the substrate using high speed imaging
>
> comparing the acquired high speed image to each one of a plurality of stored image patterns; and

converting the acquired high speed image into a layer thickness measurement when the acquired high speed image corresponds to one of said plurality of stored image patterns.

Thus, an image is taken of a substrate using high speed imaging while the substrate is being polished. The image is compared to stored image patterns and, when a corresponding stored image pattern is found, the acquired image is converted to a layer thickness measurement.

2. O'Boyle Does Not Teach High Speed Imaging or Conversion as Claimed

O'Boyle does not teach, suggest or disclose all of the elements of claim 1. In particular, O'Boyle does not teach, suggest or disclose high speed imaging of a substrate while the substrate is being polished or converting a single image into a layer thickness.

The Examiner has alleged that "O'Boyle discloses a high speed imaging device". (Final Office Action at p. 2). The Examiner further alleged that O'Boyle disclosed "converting the high speed image to the layer thickness", citing column 32, lines 27-29. (Id.). Significantly, the Examiner did not allege that O'Boyle disclosed imaging a substrate *during the polishing of the substrate.*

Claim 1 is clearly limited to a method that occurs "during CMP of the substrate". O'Boyle clearly does not obtain images of any kind *while* a substrate is being polished. The advantage lauded by O'Boyle was that layer thickness was determined "while [the chip] remains chucked in the polish tool". (O'Boyle at column 3, lines 61-65). However, the imaging unit of O'Boyle is located in a rinse tank 1, wherein it is intended to "provide a continuous optical medium free of slurry". (Id. at column 2, lines 63-66). Thus, polishing is stopped, and the wafer is moved to a rinse area to obtain a measurement. (Id.

at column 5, lines 7-13). Therefore, O'Boyle does not disclose the limitation that the imaging is performed *during* the polishing of the substrate.

Claim 1 further requires high speed imaging of the substrate. O'Boyle makes no mention whatsoever of high speed imagery. O'Boyle refers to the use of a "conventional charge coupled device (CCD)" and a polychromatic white light to obtain images of the substrate in the rinse tank. (O'Boyle at column 3, lines 11-16). Nothing about this description suggests or implies the use of high speed imaging. O'Boyle also uses a monochrometer between the light source and the substrate to provide specific wavelengths of light to the substrate. (Id. at column 4, line 62 through column 5, line 6). Once again, there is no disclosure whatsoever of high speed imaging or any need therefor. As a consequence, contrary to the Examiner's assertion, O'Boyle does not disclose high speed imaging.

The Examiner made reference to column 3, lines 25-27 in alleging that O'Boyle disclosed the step of converting an image to a layer thickness. The portion of O'Boyle relied upon by the Examiner is primarily directed to introducing the system of O'Boyle, and merely summarizes the function of the various components. (O'Boyle at column 3, lines 36-41). The method actually disclosed is set forth in column 4, line 1 through column 5, line 18. There, O'Boyle clearly states that a series of images taken over a series of wavelengths are converted into "an interference spectrum". (Id. at column 4, line 64 through column 5, line 1). This spectrum, which is a compilation of data from a number of images, is used to determine a layer thickness. (Id. at column 5, lines 1-4). A compilation of images is not a single "high speed image" as claimed. Therefore, O'Boyle does not disclose the conversion of a high speed image into a layer thickness.

For the foregoing reasons, it is respectfully submitted that O'Boyle fails to disclose or suggest each and every element of claim 1. As a consequence, the anticipation rejection is in error and should be reversed.

Discussion re: Patentability of Claim 2

Claim 2 also stands rejected as allegedly being obvious over O'Boyle. Claim 2 depends from and incorporates all of the limitations of claim 1. Accordingly, for at least the same reasons as those set forth above in connection with claim 1, it is respectfully submitted that claim 2 is patentable over the prior art.

Discussion re: Patentability of Claims 3-6

Claims 3-6 stand rejected as allegedly being obvious over O'Boyle in view of Bibby. The Examiner relied upon Bibby for teaching "light source with a spectrum between 200 and 1000 nm (see col. 6, lines 13-17) and the thickness measurements using the pixel conversion (see col. 7, lines 20-27) as claimed." (Final Office Action at page 4).

Claims 3-6 all depend from and incorporate all the limitations of claim 1 either directly or through other claims. As discussed above, O'Boyle fails to disclose a number of limitations in claim 1. Substitution of the tungsten light source of Bibby for the halogen light source of O'Boyle does not address the deficiencies of O'Boyle with respect to claim 1. Accordingly, it is respectfully submitted that claims 3-6 are patentable over the prior art for at least the same reasons as those set forth above in connection with claim 1.

Second Claim Grouping: Claim 7 is Not Unpatentable Over the Prior Art

Discussion re: Patentability of Claim 7

1. Claim 7 depends from Claim 1

As an initial matter, claim 7 depends from and incorporates all the limitations of claim 1. Accordingly, in addition to the reasons discussed below, claim 7 is patentable over the prior art for at least the same reasons as those set forth above in connection with claim 1.

2. Additional Limitations of Claim 7

Claim 7 depends from claim 1 and includes the following limitation:

> wherein the step of converting the corresponding acquired high speed image into a thickness measurement includes the step of converting pixels of the acquired high speed image into layer thickness.

Thus, pixels of a high speed image are converted into layer thickness.

3. Combination of O'Boyle and Bibby is Improper

Claim 7 is also patentable for reasons independent of those discussed above in connection with claim 1. Claim 7 includes an additional limitation directed to converting pixels of a high speed image into layer thickness. The Examiner relied upon Bibby for teaching "light source with a spectrum between 200 and 1000 nm (see col. 6, lines 13-17) and the thickness measurements using the pixel conversion (see col. 7, lines 20-27) as claimed." (Final Office Action at page 4). The combination of O'Boyle and Bibby for

this purpose is improper.

If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). O'Boyle teaches that a monochrometer is used to scan over a range of wavelengths. (O'Boyle at column 4, lines 64-66). Thus, a monochromatic light is used to illuminate a substrate. With a specific wavelength of light illuminating the substrate, an image is taken. (Id. at column 4, lines 65-67). This image represents a single data point in a spectral plot. The wavelength of light is then incremented, and an additional image is taken. By storing up a series of images, each image representing a single frequency of reflected light, a series of data points is obtained so as to generate a spectral plot of the reflectance of the substrate is obtained. (Id. at column 4, line 64 through column 5, lines 1). From the series of images, film thickness is calculated. (Id. at column 5, lines 1-5). Although not stated, it is clear that a series of images is needed in order to obtain acceptable accuracy.

In contrast, Bibby illuminates a substrate with a polychromatic light. (Bibby at column 6, lines 13-16). The light reflected off of a substrate is directed to a spectrometer wherein the broad band light is spread in accordance with its constituent wavelengths. (Id. at column 7 lines 19-20). The separated light is directed to a CCD comprised of a number of pixels. Each pixel is sensitive to a certain narrow wavelength of light. (Id. at column 7, lines 20-24). Thus, each image of Bibby generates on the order of 512 data points, although 980 pixels or even more may be used, each pixel representing a data point. (Id. at column 7, lines 30-40). From this single image, substrate thickness may be

determined. (Id. at column 11, lines 51-55). However, Bibby notes that various techniques should be used to improve accuracy, such as, averaging multiple images. (Id. at column 9, lines 8-41).

As proposed by the Examiner, the system of O'Boyle is used to obtain a single image. The method of O'Boyle is then modified to use the disclosure of Bibby for determination of a substrate thickness based upon the data captured in the single image. Thus, the Examiner has proposed using a single data point at a single frequency, to generate a substrate thickness measurement. This is contrary to the teaching of O'Boyle (a series of images resulting in a series of data points) and the teaching of Bibby (a single image generating 512 or more data points). The Examiner has provided no logical basis for the proposition that a single data point can be effectively used in a method that is taught to be used with 512, 980, or even more data points. It is obvious that the proposed modification would result in completely unacceptable thickness measurement error. Thus, as modified, O'Boyle would be unsatisfactory for its intended purpose. Therefore, combination of O'Boyle and Bibby is improper.

Accordingly, it is respectfully submitted that claim 7 is patentable over the prior art for all of the above reasons.

Third Claim Grouping: Claims 8-14 are Not Unpatentable Over the Prior Art

Discussion re: Patentability of Claim 8

1. Claim 8 depends from Claim 1

As an initial matter, claim 8 depends from and incorporates all the limitations of claim 1. Accordingly, claim 8 is patentable over the prior art for at least the same reasons

as those set forth above in connection with claim 1.

2. Additional Limitations of Claim 8

Claim 8 depends from claim 1 and includes the following limitation:

> The method of claim 1, wherein said determination of layer thickness of the substrate is performed in situ.

Thus, the layer thickness determination is performed *in situ*.

3. O'Boyle Does Not Teach In Situ Thickness Determination as Claimed

Claim 8 is also patentable for reasons independent of those discussed above in connection with claim 1. Claim 8 stands rejected as allegedly being obvious over O'Boyle. With respect to claim 8, the Examiner relied upon O'Boyle for additionally teaching that "layer thickness is performed in situ" (sic) citing to column 1, lines 5-7. (Final Office Action at page 3). The passage cited by the Examiner merely states that the method of O'Boyle is "for making in process thin film thickness measurements". (O'Boyle at column 1, lines 5-7). *The Random House College Dictionary*, 1975 Revised Ed., defines "process" as "a systematic series of *actions*". (Emphasis added). The specification of O'Boyle supports this interpretation as it states that a polish process includes a number of operations to be performed in order. (Id. at column 3, lines 43-46). Moreover, the imaging of O'Boyle is performed, not in the polishing area, but after "moving the wafer to the rinse area". Thus, as used in O'Boyle, it is clear that "process" refers to "actions", not locations.

The Random House College Dictionary defines "in situ" as "in its original place". Clearly, the "in situ" limitation is directed to a location, and not an action. Specifically,

as described above, the "in situ" limitation is identified as being shown in Fig. 2. Thus, the "in situ" limitation is to be defined as a determination of thickness while the substrate is not moved from its original position, that is, the position the substrate is in as it is being polished. This is in contrast to a determination made while polishing wherein the substrate is moved so as to expose some of the substrate to an imager not mounted within the pad. In contrast, O'Boyle specifically moves a wafer to a rinse tank where there is no polishing occurring. Therefore, O'Boyle does not disclose determination of layer thickness *in situ*.

Accordingly, it is respectfully submitted that claim 8 is patentable over the prior art for all of the above reasons.

Discussion re: Patentability of Claim 9

Claim 9 is an apparatus claim and claim 8 is a method claim. Claim 9, nevertheless, includes the following limitations:

> An apparatus for determining layer thickness of a particular area of a substrate during CMP of the substrate comprising:
>
> a high speed imager adapted to acquire an image of a particular area of the substrate in situ;
>
> a processing unit in electronic communication with said high speed imager;
>
> memory in electronic communication with said processing unit and containing a plurality of instructions which, when executed by said processing unit, causes said processing unit to:
>
> compare the image acquired by said high speed imager to each one of a plurality of image patterns stored in said memory device; and
>
> convert the acquired image into a layer thickness measurement when said acquired image corresponds to one of said plurality of image patterns stored in said memory device.

Thus, claim 9 requires an apparatus for use while a substrate is being polished that includes a high speed imager adapted to be used *in situ*, and a memory including instructions to compare an image acquired by the high speed imager to stored image patterns and to convert the acquired image to a layer thickness measurement when the

acquired image corresponds to a stored image pattern. These limitations are the same limitations discussed above with respect to claim 8, albeit in an apparatus form. Therefore, for all of the same reasons set forth for the similar limitations discussed above with respect to claims 1 and 8, it is respectfully submitted that claim 9 is patentable over the prior art.

Discussion re: Patentability of Claims 10-11 and 13-14

Claims 10-11 and 13-14 stand rejected as allegedly being obvious over O'Boyle in view of Bibby. The Examiner relied upon Bibby for teaching a "light source with a spectrum between 200 and 1000 nm (see col. 6, lines 13-17) and the thickness measurements using the pixel conversion (see col. 7, lines 20-27) as claimed." (Final Office Action at page 4). Claims 10-11 and 13-14 all depend from and incorporate all the limitations of claim 9 either directly or through other claims. As discussed above, O'Boyle fails to disclose a number of limitations in claim 9. Substitution of the tungsten light source of Bibby for the halogen light source of O'Boyle does not correct the deficiencies of O'Boyle as discussed above with respect to claim 9. Accordingly, it is respectfully submitted that claims 10-11 and 13-14 are patentable over the prior art for at least the same reasons as those set forth above in connection with claim 9.

Discussion re: Patentability of Claim 12

Claim 12 stands rejected as allegedly being obvious over O'Boyle. Claim 12 depends from and incorporates all of the limitations of claim 9. Accordingly, for at least the same reasons as those set forth above in connection with claim 9, it is respectfully

submitted that claim 12 is patentable over the prior art.

Fourth Claim Grouping: Claims 15-20 and 23-28 are Not Unpatentable Over the Prior Art

Discussion re: Patentability of Claim 15

1. Claim 15

Claim 15 stands rejected as allegedly being obvious over O'Boyle in view of Bibby. Claim 15 includes the following limitations:

> A method of determining end-point during CMP of a substrate comprising the steps of:
> acquiring an image of an area of the substrate using a high speed imager;
> comparing the acquired image to stored image patterns;
> converting the acquired image into a layer thickness measurement when the acquired images corresponds to one of the compared stored image patterns; and
> stopping CMP when the layer thickness measurement is a predetermined valued indicating end-point.

Thus, a high speed imager is used to take an image of a substrate while the substrate is being polished. The image is compared to stored image patterns and, when a corresponding stored image pattern is found, the image is converted into a layer thickness measurement. Additionally, the polishing is stopped when the layer thickness measurement is at a predetermined value.

2. O'Boyle does not Teach the Claimed Method

Claim 15 is an independent method claim. Nonetheless, it includes some limitations that are similar to limitations discussed above. Specifically, the limitations of a method (i) performed during polishing, (ii) using a high speed imager, (iii) comparing the acquired image to stored image patterns, and (iv) converting the acquired image to a layer thickness measurement when the acquired image corresponds to a stored image

pattern, are all similar to limitations discussed above with respect to claim 1. The Examiner relied upon O'Boyle for allegedly disclosing these elements. (Final Office Action at page 3). Therefore, for all of the reasons set forth above with respect to the similar limitations of claim 1, it is respectfully submitted that claim 15 is patentable.

3. Combination of O'Boyle and Bibby is Improper

Claim 15 is also patentable for reasons independent of those discussed above in connection with claim 1. Claim 15 includes an additional limitation directed to stopping the polishing when the layer thickness measurement is at a predetermined value. The Examiner acknowledged that O'Boyle does not disclose this limitation, but cited to Bibby for teaching "stopping CMP when the layer measurement ... (sic) end point", citing to Fig. 6 and column 12, lines 34-45 and the abstract. (Id. at page 3). The combination of O'Boyle and Bibby is improper.

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959). As discussed above, O'Boyle discloses a method and apparatus wherein the polishing of a substrate is stopped, the wafer is moved to a rinse tank, and an image is taken in the rinse tank. The rinse tank is used so as to provide "a continuous optical medium free of slurry." (O'Boyle at column 2, lines 66-67). Even without accounting for the time top move to the rinse tank, the imaging and computations of O'Boyle can take up to 2.0 seconds. (Id. at column 5, lines 4-5). Because the measurement of O'Boyle is not taken during polishing, a method of

calculating a future end point and controlling the polishing of the substrate based upon that calculation is disclosed. (See e.g. id. at column 5, lines 7-13). Thus, O'Boyle discloses stopping polishing to either take a measurement, or based upon an estimated time to obtain a desired layer thickness

In contrast, Bibby discloses a method an apparatus that are used while a substrate is actually being polished, thus, slurry within the sampled area of the substrate must be accounted for. (See e.g. Bibby at column 8, line 64 through column 9, line 7). Moreover, end points can be determined on the order of once per second. (Id. at column 8, lines 8). Because the process of Bibby is done during polishing, the determined end points can be used to stop the polishing.

Therefore, to use the disclosure of Bibby, that is, to use the determined end point as a control signal to stop the polishing, of O'Boyle, the apparatus of O'Boyle would have to be modified to take images within the polishing area, while the substrate was being polished. Because the imaging and comparison process of O'Boyle takes up to 2.0 seconds, and because it is at least inferred that the equipment of O'Boyle would not work in the presence of slurry, wholesale reconstruction and redesign of the apparatus of O'Boyle would be required to incorporate the teaching of Bibby. Thus, combination of O'Boyle and Bibby is not proper. Because the Examiner admitted that O'Boyle does not disclose the "end point" limitation, and because combination of O'Boyle and Bibby is improper, it is respectfully submitted that claim 15 is patentable over the prior art.

Accordingly, it is respectfully submitted that claim 15 is patentable over the prior art for all of the above reasons.

Discussion re: Patentability of Claims 16-20

Claims 16-20 stand rejected as allegedly being obvious over O'Boyle in view of Bibby. Claims 16-20 each depend from and incorporate all of the limitations of independent claim 15 either directly or indirectly. Therefore, at least for the reasons set forth above with respect to claim 15, it is respectfully submitted that claims 16-20 are patentable over the prior art.

Discussion re: Patentability of Claims 23-28

Claims 23-28 stand rejected as allegedly being obvious over O'Boyle in view of Bibby. Claims 23-28 are apparatus claims which include limitations similar to those discussed above with respect to claim 15. Specifically, claims 24-28 each depend, directly or indirectly, from claim 23 which recites the following limitations:

> An apparatus for determining end-point of an area of a substrate during CMP of the substrate comprising:
> a high speed imager configured to acquire images of the substrate in situ;
> a processing unit in electronic communication with said high speed imager;
> a memory device in electronic communication with said processing unit and containing a plurality of instructions which, when executed by said processing unit, causes said processing unit to:
> compare images of the substrate acquire by said high speed imager to image patterns stored in said memory device;
> convert an acquired image into a layer thickness measurement when said acquired image corresponds to a selected image pattern stored in said memory device; and
> stopping CMP when the layer thickness measurement equals a predetermined value indicating end-point.

As a consequence, each of claims 23-28 include the limitations of (i) an apparatus used during polishing, (ii) that includes a high speed imager, (iii) an imager configured to be used *in situ*, (iv) a memory device including instructions to compare acquired high speed images to stored image patterns, (v) a memory device including instructions to convert an image to a layer thickness measurement if the acquired image corresponds to a

stored image pattern, and (vi) a memory device including instructions to stop polishing when the layer thickness measurement equals a predetermined value. These limitations are similar to limitations discussed above with respect to claim 15. Therefore, at least for the reasons set forth with respect to the similar limitations of claim 15, it is respectfully submitted that claims 23-28 are patentable over the prior art.

Fifth Claim Grouping: Claim 21 is Not Unpatentable Over the Prior Art

Discussion re: Patentability of Claim 21

1. Claim 21 depends from Claim 15

As an initial matter, claim 21 depends from and incorporates all the limitations of claim 15. Accordingly, claim 21 is patentable over the prior art for at least the same reasons as those set forth above in connection with claim 15.

2. Additional Limitations of Claim 21

Claim 21 depends from claim 15 and includes the following limitation:

> The method of claim 15, wherein the step of converting the acquired image into a thickness measurement when the acquired image corresponds to one of the compared stored image patterns includes the step of converting pixels of the acquired image into layer thickness.

Thus, pixels of a high speed image are converted into layer thickness.

3. Combination of O'Boyle and Bibby Is Improper

Claim 21 is also patentable for reasons independent of those discussed above in connection with claim 15. Claim 21 stands rejected as allegedly being obvious over O'Boyle in view of Bibby. The Examiner relied upon Bibby for teaching "light source

with a spectrum between 200 and 1000 nm (see col. 6, lines 13-17) and the thickness measurements using the pixel conversion (see col. 7, lines 20-27) as claimed." (Final Office Action at page 4). As discussed with respect to claim 7 above, combination of O'Boyle and Bibby is improper.

Accordingly, it is respectfully submitted that claim 21 is patentable over the prior art for all of the above reasons.

Sixth Claim Grouping: Claim 22 is Not Unpatentable Over the Prior Art

Discussion re: Patentability of Claim 722

1. Claim 22 depends from Claim 15

As an initial matter, claim 22 depends from and incorporates all the limitations of claim 15. Accordingly, claim 22 is patentable over the prior art for at least the same reasons as those set forth above in connection with claim 15.

2. Additional Limitations of Claim 22

Claim 22 depends from claim 15 and includes the following limitation:

> The method of claim 15, wherein said determination of end-point during CMP of a substrate is performed in situ.

Thus, end-point determination is performed *in situ* during polishing.

3. O'Boyle Does Not Teach In Situ Thickness Determination as Claimed

Claim 22 is also patentable for reasons independent of those discussed above in

connection with claim 15. Claim 22 is also patentable for reasons independent of those discussed above in connection with claim 1. Claim 22 stands rejected as allegedly being obvious over O'Boyle. With respect to claim 22, the Examiner relied upon O'Boyle for additionally teaching that "layer thickness is performed in situ" (sic) citing to column 1, lines 5-7. (Final Office Action, page 3). As discussed above with respect to claim 8, O'Boyle does not disclose determination of layer thickness *in situ*.

Accordingly, it is respectfully submitted that claim 22 is patentable over the prior art for all of the above reasons.

(9) CONCLUSION

For all of the foregoing reasons, claims 1-28 are not unpatentable under 35 U.S.C. § 103(a). As a consequence, the Board of Appeals is respectfully requested to reverse the rejection of these claims.

Respectfully submitted,

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CLAIM APPENDIX

1. A method of determining layer thickness of a particular area of a substrate during CMP of the substrate, the method comprising the steps of:

acquiring an image of a particular area of the substrate using high speed imaging;

comparing the acquired high speed image to each one of a plurality of stored image patterns; and

converting the acquired high speed image into a layer thickness measurement when the acquired high speed image corresponds to one of said plurality of stored image patterns.

2. The method of claim 1, wherein the step of acquiring a high speed image of a particular area of the substrate includes the steps of:

projecting a conventional light source onto the substrate; and

utilizing a high speed camera.

3. The method of claim 1, wherein the step of acquiring a high speed image of a particular area of the substrate includes the steps of:

delivering a pulse of light from a coherent light source onto the particular area of the substrate; and

utilizing a conventional camera.

4. The method of claim 3, wherein said coherent light source comprises a laser.

5. The method of claim 1, wherein the step of acquiring a high speed image of a particular area of the substrate includes the steps of:

delivering a pulse of light from a broad band light source onto the particular area of the substrate; and

utilizing a conventional camera.

6. The method of claim 5, wherein the said broad band light source comprises a flash lamp.

7. The method of claim 1, wherein the step of converting the corresponding acquired high speed image into a thickness measurement includes the step of converting pixels of the acquired high speed image into layer thickness.

8. The method of claim 1, wherein said determination of layer thickness of the substrate is performed in situ.

9. An apparatus for determining layer thickness of a particular area of a substrate during CMP of the substrate comprising:

a high speed imager adapted to acquire an image of a particular area of the substrate in situ;

a processing unit in electronic communication with said high speed imager;

memory in electronic communication with said processing unit and containing a plurality of instructions which, when executed by said processing unit, causes said processing unit to:

compare the image acquired by said high speed imager to each one of a plurality of image patterns stored in said memory device; and

convert the acquired image into a layer thickness measurement when said acquired image corresponds to one of said plurality of image patterns stored in said memory device.

10. The apparatus of claim 9, wherein said high speed imager comprises:

a pulsed, coherent light source; and

a conventional camera.

11. The apparatus of claim 10, wherein said coherent light source comprises a laser.

12. The apparatus of claim 9, wherein said high speed imager comprises:

a conventional light source; and

a high speed camera.

13. The apparatus of claim 9, wherein said high speed imager comprises:

a pulsed, broad band light source; and

a conventional camera.

14. The apparatus of claim 13, wherein said broad band light source comprises a flash lamp.

15. A method of determining end-point during CMP of a substrate comprising the steps of:

acquiring an image of an area of the substrate using a high speed imager;

comparing the acquired image to stored image patterns;

converting the acquired image into a layer thickness measurement when the acquired images corresponds to one of the compared stored image patterns; and

stopping CMP when the layer thickness measurement is a predetermined valued indicating end-point.

16. The method of claim 15, wherein the step of acquiring an image of an area of the substrate includes the steps of:

projecting a conventional light source onto the area of the substrate; and

utilizing a high speed camera.

17. The method of claim 15, wherein the step of acquiring an image of an area of the substrate includes the steps of:

delivering a pulse of light from a coherent light source onto the area of the substrate; and

utilizing a conventional camera system.

18. The method of claim 17, wherein said coherent light source comprises a laser.

19. The method of claim 15, wherein the step of acquiring an image of an area of the substrate includes the steps of:

delivering a pulse of light from a broad band light source onto the area of the substrate; and

utilizing a conventional camera.

20. The method of claim 19, wherein said broad band light source comprises a flash lamp.

21. The method of claim 15, wherein the step of converting the acquired image into a thickness measurement when the acquired image corresponds to one of the compared stored image patterns includes the step of converting pixels of the acquired image into layer thickness.

22. The method of claim 15, wherein said determination of end-point during CMP of a substrate is performed in situ.

23. An apparatus for determining end-point of an area of a substrate during CMP of the substrate comprising:

a high speed imager configured to acquire images of the substrate in situ;

a processing unit in electronic communication with said high speed imager;

a memory device in electronic communication with said processing unit and containing a plurality of instructions which, when executed by said processing unit, causes said processing unit to:

compare images of the substrate acquire by said high speed imager to image patterns stored in said memory device;

convert an acquired image into a layer thickness measurement when said acquired image corresponds to a selected image pattern stored in said memory device; and

stopping CMP when the layer thickness measurement equals a predetermined value indicating end-point.

24. The apparatus of claim 23, wherein said high speed imager comprises:

a pulsed, coherent light source; and

a conventional camera.

25. The apparatus of claim 24, wherein said coherent light source comprises a laser.

26. The apparatus of claim 23, wherein said high speed imager comprises:

a conventional light source; and

a high speed camera.

27. The apparatus of claim 23, wherein said high speed imager comprises:

a pulsed, broad band light source; and

a conventional camera.

28. The apparatus of claim 27, wherein said broad band light source comprises a flash lamp.